

IN THE CLAIMS:

Please amend the claims as follows.

1. (Amended) A lithographic projection apparatus comprising:
- a radiation system for supplying a projection beam of radiation;
 - a first object table provided with a mask holder for holding a mask;
 - a second, movable object table provided with a substrate holder for holding a substrate and having a physical reference surface fixed thereto;
 - a projection system for imaging an irradiated portion of the mask onto a target portion of the substrate; [and]
 - a positioning system for moving said second object table between an exposure station, at which said projection system can image said mask portion onto said substrate, and a measurement station; [characterized in that
 - said second object table has a physical reference surface fixed thereto;
 - and by:]
 - a height mapping system [means] located at said measurement station and constructed and arranged to measure [the height] heights, relative to said physical reference surface, of a plurality of points on a [the] surface of a substrate held on said substrate holder and to create a height map thereof;
 - a position measuring system [means] located at said exposure station for measuring a [the] position of said physical reference surface in a first direction substantially perpendicular to said substrate surface, after movement of said second object table to said exposure station; and
 - a position controller [control means] constructed and arranged to control the position of said second object table in at least said first direction, during exposure of said

target portion, in accordance with said height map and said position measured by said position measuring means.

2. (Amended) Apparatus according to claim 1 wherein said controller [control means] is further arranged to control the tilt of said second object table about at least one axis perpendicular to said first direction in accordance with said height map.

3. (Amended) Apparatus according to claim 1 [or 2] wherein said height mapping system [means] comprises a level sensor constructed and arranged to simultaneously measure [the position] positions in said first direction of a linear array of points.

4. (Amended) Apparatus according to claim 1, [2 or 3,] wherein said height mapping system [means] comprises a level sensor constructed and arranged to measure a [the] position of a measurement beam reflected by the surface whose position in said first direction is to be measured.

5. (Amended) Apparatus according to claim 4 wherein said level sensor comprises:

a projection grating;

projection optics for projecting an image of said projection grating onto the surface whose position in said first direction is to be measured;

a detection grating; [,]

detection optics for focusing light reflected by said surface to form on said detection grating an image of said projection grating; and

a detector for detecting Moiré patterns formed by an [the] overlay of said image of said projection grating on said detection grating.

6. (Amended) Apparatus according to claim 5, wherein said level sensor further comprises a radiation source constructed and arranged to illuminate said projection grating

with polychromatic radiation and wherein said projection optics and said detection optics comprise [consist essentially of] reflective optical elements.

7. (Amended) Apparatus according to [any one of the preceding claims] claim 1, wherein said height mapping system [means] comprises a level sensor for detecting [the position] positions in said first direction of the surface of said substrate at said plurality of points and a position detector [detector means] for detecting the position in said first direction of said second object table simultaneously with measurements by said level sensor.

8. (Amended) Apparatus according to claim 7 wherein said position detector [detection means] comprises an interferometer.

9. (Amended) Apparatus according to claim 1, [any one of the preceding claims] wherein said position system [means] comprises an image sensor mounted to said second object table and said physical reference surface comprises an upper surface of said image sensor.

10. (Amended) Apparatus according to claim 1 [any one of the preceding claim], wherein said position measuring system [means] is constructed and arranged to measure the position of said physical reference surface relative to the focal plan of said projection system.

11. (Amended) Apparatus according to claim 1, [any one of the preceding claims] wherein:

said second object table has a plurality of spaced-apart physical reference surfaces; and

said height mapping system [means] is constructed and arranged to measure [the height] heights of said plurality of points relative to a reference plane defined by said plurality of physical reference surfaces.

12. (Amended) Apparatus according to claim 1, [any one of the preceding claims] further comprising:

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a second height mapping system [means] located at said exposure station constructed and arranged to measure [the height] heights, relative to said physical reference surface, of said plurality of points on the surface of a substrate held on said substrate holder and to create a height map thereof; and

a height calibrator [calibration means] constructed and arranged to compare height maps of a single substrate prepared by each of said first and second height mapping systems [means] to derive a relative calibration for separate position detection systems provided at said measurement and exposure stations.

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13. (Amended) A method of manufacturing a device using a lithographic projection apparatus comprising:

[a radiation system for supplying a projection beam of radiation;
a first object table provided with a mask holder for holding a mask;
a second, movable object table provided with a substrate holder for holding a substrate; and

a projection system for imaging irradiated portions of the mask onto target portions of the substrate at an exposure station; the method comprising the steps of:]

providing a mask bearing a pattern on [to said] a first object table;
providing a substrate having a radiation-sensitive layer on [to said] a second, movable object table; [and]

imaging [said] irradiated portions of the mask onto [said] target portions of [the] a substrate at an exposure station; [characterized by the steps of:]

wherein before said [step of] imaging, generating, with the second object table at a measurement station, a height map indicating [the height] heights of a plurality of points on the substrate surface relative to a physical reference surface on said second object table;

moving the second object table to said exposure station and measuring [the] a position of said physical reference surface in a first direction substantially perpendicular to said substrate surface; and

during said [step of] imaging, positioning the second object table in at least said first direction by reference to said height map and said measured position in said first direction of said physical reference surface.

15. (Amended) A method according to claim 13 [or 14] wherein said second object table is positioned during said imaging [step] so as to minimize [the] square defocus integrated over the area of said target portion, wherein [the] defocus is defined as [comprises] the distance in said first direction between the focal surface of said projection lens and the surface of said substrate.

16. (Amended) A method according to claim 13 [or 14] wherein:
said [step of] imaging comprises scan imaging a slit image onto said substrate; and
said second object table is positioned during said imaging step so as to minimize [the] square defocus integrated over the duration of said scanning exposure and [the] an area of said slit image,

wherein the defocus is defined as [comprises the] a distance in said first direction between [the] a focal surface of said projection lens and [the] said surface of said substrate.

17. (Amended) A method according to claim 13 [any one of claims 13 to 16] wherein said [step of] generating [a] said height map further comprises [the substeps of]:
measuring [the position] positions in said first direction [of each] of said plurality of points on said substrate surface;

simultaneously with each measurement of the position of each [a] point on said substrate surface, measuring a [the] position in said first direction of said second object table; and

subtracting each measured position of said second object table from [the] a corresponding measured position of said substrate surface to generate said height map.

18. (Amended) A method according to claim 17, wherein [said step of] generating [a] said height map further comprises first [the initial step of] measuring a [the] position in said first direction of said physical reference surface and simultaneously a [the] position in said first direction of said second object table.

19. (Amended) A method according to claim 13, further [any one of claims 13 to 18] comprising:

[the further steps] before [said step of] generating [a] said height map, [of:] measuring [height] heights of a plurality of points on said wafer surface adjacent [the perimeter] perimeters of areas on said substrate that are to be exposed, and

determining from the measured heights parameters selected from the group consisting of: an overall height and tilt for said substrate [and/or]; local height [or tilt values in certain regions of said substrate surface whose height is to be mapped] in a selected region of said substrate surface whose height is to be mapped, and local tilt in said selected region of said substrate surface whose height is to be mapped.

20. (Amended) A method according to claim 13, [any one of claims 13 to 19] further comprising: [the step,]

before said [step of] generating [a] said height map, [of] calibrating a level sensor to be used in generating said height map by using said level sensor to make a plurality of measurements of the vertical position of at least one predetermined point on said substrate surface with the second object table being positioned at different vertical positions for different ones of said plurality of measurements.

21. (Amended) A method according to claim 20 wherein said [step of] calibrating is preformed for a plurality of different exposure areas on said substrate and respective resulting calibration corrections are applied in generating the height map for exposure areas corresponding in type to those for which the calibration was performed.

22. (Amended) A device manufactured according to the method of claim 13 [any one of claims 13 to 21].

23. (Amended) A method of manufacturing a device using a lithographic projection apparatus, comprising:

[a radiation system for supplying a projection beam of radiation;
a first object table provided with a mask holder for holding a mask;
a second, movable object table provided with a substrate holder for holding a substrate; and
a measurement station having a first position detection system for measuring the position of said second object table at said measurement station;
an exposure station having a projection system for imaging irradiated portions of the mask onto target portions of the substrate and a second position detection system for

measuring the position of said second object table at said exposure station; the method comprising the steps of:

providing a substrate to said second object table;]

[at said measurement station,]generating a first height map of [said] a substrate at a measurement station by measuring [the position] positions in a first direction, substantially perpendicular to the surface of said substrate, of a plurality of points on said substrate surface and simultaneously measuring a [the] position of [said second] a movable object table on which said substrate is provided by using said first position detection system;

[at said exposure station,]generating a second height map of said substrate at an exposure station by measuring [the position] positions in said first direction of said plurality of points on said substrate surface and simultaneously measuring a [the] position of said [second] movable object table using [said] a second detection system; and

comparing said first and second height maps to calibrate said first and second position detection systems.

24. (Amended) A method of manufacturing devices using a lithographic projection apparatus comprising:

[a radiation system for supplying a projection beam of radiation;

a first object table provided with a substrate holder for holding a substrate; and

a projection system for imaging irradiated portions of the mask onto target portions of the substrate; the method comprising the steps of:]

providing a mask bearing a pattern on [to said] a first object table;

providing a substrate having a radiation-sensitive layer [to] on a [said] second object table; [and]

imaging [said] irradiated portions of the mask onto said target portions of the substrate;

said [steps of] providing a substrate and said imaging being repeated to expose a plurality of substrates; [characterized by the steps of:]

generating, for each substrate provided to said second object table, a height map indicating [the height] heights of a plurality of points on the substrate surface; and

comparing the height maps of successively provided substrates to detect correlations in the locations of any unflatnesses that may be indicative of [contamination or systematic faults] flaws of said second object table.

25. (Amended) A lithographic projection apparatus comprising:

a radiation system for supplying a projection beam of radiation;

a first, movable object table provided with a mask holder for holding a reflective mask;

a second[,] object table provided with a substrate holder for holding a substrate; [and]

a projection system for imaging an irradiated portion of the mask onto a target portion of the substrate; [characterized by]

a height mapping [means] system constructed and arranged to measure the height, relative to a reference surface, of each of a plurality of points on [the] a plane of a reflective mask held on said mask holder and to create a height map thereof; and

[control means] a position controller constructed and arranged to control the position of said first object table in at least said first direction, during exposure of said target portion, in accordance with said height map.

26. (Amended) A method of manufacturing a device using a lithographic projection apparatus comprising:

[a radiation system for supplying a projection beam of radiation;

a first, movable object table provided with a mask holder for holding a reflective mask;

a second object table provided with a substrate holder for holding a substrate;

and]

a projection system for imaging irradiated portions of the mask onto target portions of the substrate; the method comprising the steps of:]

providing a reflective mask bearing a pattern to [said] a first object table;

providing a substrate having a radiation-sensitive layer to [said] a second object table; [and]

imaging [said] irradiated portions of the mask onto [said] target portions of the substrate; [characterized by the steps of:]

before said [step of] imaging, generating[,] a height map indicating [the height] heights of a plurality of points on the mask surface relative to a reference plane on said first object table; and

during said [step of] imaging, positioning the first object table in at least said first direction by reference to said height map.